

Mar 15 2 45 PM '97

Before the  
Federal Communications Commission  
Washington, D.C. 20554

In the Matter of	)	IB Docket No. 95-91
	)	GEN Docket No. 90-357
	)	RM No. 8610
Establishment of Rules and Policies for the	)	PP-24
Digital Audio Radio Satellite Service in the	)	PP-86
2310-2360 MHz Frequency Band	)	PP-87

**REPORT AND ORDER  
MEMORANDUM OPINION AND ORDER  
AND FURTHER NOTICE OF PROPOSED RULEMAKING**

**Adopted: March 3, 1997**

**Released: March 3, 1997**

Comment Date: May 2, 1997  
Reply Comment Date: May 23, 1997

By the Commission: Chairman Hundt issuing a statement; Commissioner Ness approving in part, concurring in part, and issuing a statement; Commissioner Chong issuing a statement.

**TABLE OF CONTENTS**

	Paragraph
I. INTRODUCTION .....	1-4
II. BACKGROUND .....	5-6
III. ISSUES TO BE RESOLVED	
A. Public Interest Benefits and Economic Impact .....	7-9
1. Public Interest Benefits .....	10-17
2. Impact on Terrestrial Radio Listenership .....	18-21
3. Impact on Terrestrial Radio Advertising Revenues .....	22-25
4. Effects on Terrestrial Stations' Profitability and Viability .....	26-34
5. Related Challenge to DARS Allocation .....	35-38
B. Licensing Plan	
1. Licensing Options for Satellite DARS Spectrum .....	39-41
2. Spectrum Requirements and Economic Viability .....	42-50
3. International Coordination Obligations .....	51-58
4. Pioneer's Preference Requests .....	59-61
5. Cut-off Issues .....	62-71
6. Specific Frequency Assignments and Satellite DARS Competition ...	72-78
7. Licensing Conditions .....	79-80
C. Service Rules for Satellite DARS	
1. Classification of Service .....	81-84

---

2. Public Interest Obligations . . . . .	85-93
3. Ancillary Services . . . . .	94-96
4. Technical Qualifications . . . . .	
<i>Service Area</i> . . . . .	97-99
<i>Service Link Margin</i> . . . . .	100-101
<i>Receiver Inter-operability</i> . . . . .	102-107
<i>Data Compression Rates</i> . . . . .	108-109
5. Milestone Qualifications and Reporting Requirements . . . . .	110
6. License Term . . . . .	111
7. Technical Rules . . . . .	112
<i>PFD limits</i> . . . . .	113-114
<i>Out-of-band emissions</i> . . . . .	115-118
<i>Telemetry beacons</i> . . . . .	119-121
<i>Cross polarization</i> . . . . .	122-123
D. Modification of Part 87 . . . . .	124-126
E. Satellite DARS Feederlink Networks . . . . .	127-137
F. Further Notice of Proposed Rulemaking on Terrestrial Repeaters . . . . .	138-142
G. Rules for Auctioning Satellite DARS Licenses . . . . .	143
1. Authority to Conduct Auctions . . . . .	144-152
2. Competitive Bidding Design and Bidding Procedures . . . . .	153-162
3. Procedural and Payment Issues . . . . .	163-169
4. Safeguards . . . . .	170-173
5. Designated Entity Provisions . . . . .	174-176
IV. CONCLUSION . . . . .	177
V. ORDERING CLAUSES . . . . .	178-189

APPENDIX A: Amendments to 47 C.F.R. Part 25 and Part 87 of the Commission's Rules

APPENDIX B: Final Regulatory Flexibility Analysis

APPENDIX C: Proposed Amendments to 47 C.F.R. Part 25 of the Commission's Rules

## I. INTRODUCTION

1. Digital Audio Radio Service by satellite (satellite DARS) promises to provide continuous nationwide radio programming with compact disc (CD) quality sound. Motorists on the highways of America may soon be able to tune in to one of many satellite DARS channels offering a particular format without interruption or fading as they travel across the United States. This new service also has the potential to increase the variety of programming available to the listening public. Providers may, for example, offer niche channels that would serve listeners with special interests. Satellite DARS has the technological potential to serve listeners in areas of the country that have been underserved. While, to some extent, DARS will compete with local radio, we anticipate that it will also complement terrestrial radio.

2. The Commission issued its Notice of Proposed Rulemaking (Notice) in this proceeding in June 1995.<sup>1</sup> After carefully reviewing the comments we have concluded that it is in the public interest to license satellite DARS. Opponents of the new service have not shown that its potential adverse impact on local radio service outweighs its potential benefits. Based on the record, we also find that an economically viable satellite DARS system will require at least 12.5 MHz of spectrum.

3. Although we originally allocated 50 MHz of spectrum for satellite DARS in the S-band (2310-2360 MHz), recently enacted legislation directed the Commission to reallocate 25 MHz of that spectrum (and an adjacent 5 MHz) for any services consistent with the allocation table and associated international agreements and to assign licenses for that 25 MHz by auction.<sup>2</sup> Accordingly, in this proceeding we will designate only two licenses for satellite DARS in the 25 MHz that remains in the part of the S-band previously allocated for satellite DARS. We will award both satellite DARS licenses using competitive bidding to resolve mutual exclusivity among the current applicants, under the auction rules we adopt today. We also adopt service rules for satellite DARS licensees, including milestone requirements. Finally, we seek further comment on the proposed use of terrestrial repeaters in conjunction with satellite DARS systems.

---

<sup>1</sup> Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band, 11 FCC Rcd 1 (1995)(Notice).

<sup>2</sup> See Omnibus Consolidated Appropriations Act, 1997, P.L. 104-208, 110 Stat. 3009 (1996) (Appropriations Act). This legislation directs that two band segments be reallocated and auctioned: 2345-2360 MHz and 2305-2330 MHz (this includes 5 MHz -- 2305-2310 MHz -- not previously allocated for DARS). The Commission adopted a Report and Order implementing this legislation on February 19, 1997. Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service (WCS), GN Docket No. 96-228, FCC 97-50 (released February 19, 1997) (WCS Order).

4. Although three of the four DARS applicants applied for pioneer's preferences, we do not need to decide the matter. Following unanimous recommendations from a panel of satellite experts that no pioneer's preferences be granted for satellite DARS, all three applicants have withdrawn their applications.<sup>3</sup>

## II. BACKGROUND

5. We will summarize the background in this proceeding, which is described in greater detail in the Notice and in prior orders. Satellite CD Radio, Inc. (CD Radio) initiated this proceeding in 1990 by filing a petition to allocate spectrum for satellite DARS and an application to provide the service. In February 1992, the World Administrative Radio Conference (WARC-92) adopted international frequency allocations for Broadcasting Satellite Service (BSS) (sound)(the international term for satellite DARS).<sup>4</sup> Internationally, this band is also allocated on a primary basis to radiolocation services and fixed and mobile terrestrial services. In November 1992, the Commission established a proceeding to allocate satellite DARS spectrum domestically and announced a December 15, 1992 cut-off date for satellite DARS license applications to be considered with CD Radio's. Of the six license applicants that filed before the cut-off, four remain: CD Radio, Primosphere Limited Partnership (Primosphere), Digital Satellite Broadcasting Corporation (DSBC) and American Mobile Radio Corporation (AMRC). In January 1995, the Commission allocated the 2310-2360 MHz band for satellite DARS on a primary basis.<sup>5</sup>

6. In our June 1995 Notice, we posed many questions about satellite DARS. We requested detailed information on the new service's potential economic impact on terrestrial broadcasters.<sup>6</sup> The Notice asked about the most appropriate service design and regulatory classification.<sup>7</sup> We sought comment on what public interest obligations to impose<sup>8</sup> and

---

<sup>3</sup> See Public Notice, Report No. SPB-67 (released November 19, 1996); letter from CD Radio dated November 22, 1996; letter from DSBC dated December 3, 1996; letter from Primosphere dated December 5, 1996.

<sup>4</sup> International Telecommunication Union, Final Acts of the World Administrative Radio Conference (Malaga-Torremolinos, 1992). The Conference allocated the 2310-2360 MHz band to the U.S. in Region 2. See discussion in Amendment of the Commission's Rules with Regard to the Establishment and Regulation of New Digital Audio Radio Services, 10 FCC Rcd. 2310 (1995) (Allocation Order) at ¶ 26.

<sup>5</sup> Allocation Order, supra. Primary services are protected from harmful interference from secondary services and from unacceptable interference from stations that are co-primary to which frequencies may be assigned at a later date.

<sup>6</sup> Notice, ¶¶ 10-20.

<sup>7</sup> Notice, ¶¶ 21-26.

queried whether providers should be permitted to offer ancillary services.<sup>9</sup> The Notice proposed three possible licensing options and rules to allow expeditious licensing after an option was chosen.<sup>10</sup> After the Notice was released, the Appropriations Act directed the Commission to reallocate spectrum at 2305-2320 MHz and 2345-2360 MHz for all services consistent with international allocations and to award licenses in that portion of the band using competitive bidding.<sup>11</sup> As a consequence, the licenses designated pursuant to this order will be in the spectrum between 2320 and 2345 MHz.<sup>12</sup>

### III. ISSUES TO BE RESOLVED

#### A. **Public Interest Benefits of Satellite DARS and Its Economic Impact on Terrestrial Broadcaster Service.**

7. In the Notice and in prior orders, we discussed the benefits of satellite DARS proffered by the proponents. These include introduction of a new radio service to the public, a national distribution of radio programming to all areas, including underserved and unserved areas and population groups, the creation of jobs and the promotion of technological development in the satellite and receiver industries, and the improvement of U.S. competitiveness in the international economy.<sup>13</sup> We sought comment on our tentative conclusion that satellite DARS offers substantial public benefits.<sup>14</sup>

8. We also invited detailed comment and information on the economic impact of satellite DARS on existing radio broadcasters.<sup>15</sup> We acknowledge the high level of concern that terrestrial broadcasters have expressed about satellite DARS. In addition to three

---

<sup>8</sup> Notice, ¶¶ 27-28.

<sup>9</sup> Notice, ¶¶ 29-30.

<sup>10</sup> Notice, ¶¶ 31-40.

<sup>11</sup> See note 2, supra.

<sup>12</sup> See Notice of Proposed Rulemaking, Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service (WCS Notice), WT Docket No. 96-228 (released November 12, 1996).

<sup>13</sup> Notice, ¶¶ 2,5,12; Allocation Order, ¶ 22.

<sup>14</sup> Notice, ¶ 12.

<sup>15</sup> Id., ¶¶ 11, 13-20.

associations of broadcasters, more than one hundred terrestrial radio stations owners or operators have submitted individual letters opposing satellite DARS.<sup>16</sup>

9. Recognizing the significant public value of terrestrial radio service, we must weigh the potential public interest benefits of satellite DARS against its potential adverse impact on terrestrial radio. This impact is relevant "to the extent that [it] would predictably lead to serious loss of important services to consumers, taking into account the potential for future enhancements of terrestrial broadcasting by the introduction of new technologies."<sup>17</sup> In the Notice we emphasized that, pursuant to Section 7 of the Communications Act, opponents of a new technology, such as satellite DARS, bear the burden of demonstrating that it is inconsistent with the public interest.<sup>18</sup> We have previously noted that, "The public interest in this regard is the provision of services of value to the listening public and includes the protection of competition, not competitors."<sup>19</sup>

#### 1. Public Interest Benefits

10. Satellite DARS can offer high quality radio signals to listeners who currently receive few terrestrial radio signals.<sup>20</sup> Commenters disagree concerning how many people are underserved by local radio. One respondent submitted a county-based analysis of listening diaries contending that only 6100 people in the U.S. aged 12 and over receive less than six radio signals.<sup>21</sup> However, that study defined a station as "covering" a U.S. county if even one diary recorded having received its signal. Given that AM signals travel long distances at night and that such skywave signals fluctuate significantly even when useable, we believe that such diary evidence may not accurately indicate the size of the population that receives radio signals.

---

<sup>16</sup> Entertainment Co. Inc, Mt. Wilson FM Broadcasters, Noble Broadcast Group, and Susquehanna Radio Corp. provided relatively extensive comments. Ashland Broadcasting Co., Bogue Chitto Communication Co., Coast FM Community Pacific Broadcasting Co., The Cromwell Group, Inc., Mr. Curtis of the Curtis Media Group, Hanson Communications, Knox Broadcasting Co., Paul Bunyan Broadcasting Co., Sound Broadcasters, Inc., and many others also provided comments.

<sup>17</sup> Notice, ¶ 11.

<sup>18</sup> Id.

<sup>19</sup> Id.

<sup>20</sup> The record indicates the public's interest in high quality audio. See Comments of Dolby Laboratories, p. 2; Comments of WPFW 89.3 FM; Comments of Diginet Communications Inc.

<sup>21</sup> NAB Comments, Attachment 3.

11. One study indicates that 722,102 persons (0.3% of U.S. population) are covered by no FM stations, 2.4 million persons (1.0% of U.S. population) are covered by one or fewer FM stations, and 22 million persons (8.9% of the U.S. population) are covered by five or fewer FM stations.<sup>22</sup> The NAB criticized this study, however, because it does not include AM radio stations, even though more than 40% of all radio stations are AM stations and even though AM signals often travel much further than FM signals at night.<sup>23</sup> AM signals, due to limited bandwidth and greater susceptibility to noise and interference, do not provide as high fidelity sound as FM signals.<sup>24</sup> Thus, FM signal quality may be closer to the quality of that satellite DARS would provide. While we are unable to estimate an exact figure for the number of potential radio listeners who are currently underserved, we find that the record is sufficient to indicate that a significant number of persons in the U.S. receive few high quality audio signals. Satellite DARS offers the substantial benefit of providing these persons with many additional high quality audio signals.

12. It is our view that satellite DARS will particularly benefit communities where terrestrial broadcast service is less abundant. The record shows that counties with smaller populations have fewer radio stations and that smaller markets have fewer radio formats.<sup>25</sup> The 33.2% of the U.S. population living in the top ten radio markets have access to an average of 26 formats, while the 18% of the U.S. population living in radio markets ranked 100-261 have access to an average of only 14.9 formats.<sup>26</sup> Persons living outside these 261 ranked markets are likely to have still fewer radio formats available. Given that each satellite DARS applicant proposes to provide 20 or more channels nationwide, satellite DARS would significantly reduce the proportional discrepancy in the geographic distribution of radio service.

13. Moreover, satellite DARS can provide new services that local radio inherently cannot provide. With its national reach, satellite DARS could provide continuous radio

---

<sup>22</sup> Jules Cohen study, Primosphere Comments, Exhibit 7.

<sup>23</sup> NAB Reply Comments, pp. 7-8.

<sup>24</sup> The Commission, among others, has identified these problems and made significant attempts to correct them. See, e.g., Review of the Technical Assignment Criteria for the AM Broadcast Service, MM Docket No. 87-267.

<sup>25</sup> NAB Comments, Attachments 3 and 4, and Primosphere Reply Comments, Exhibit 3.

<sup>26</sup> CD-Radio Reply, Appendix A, p. 27.

service to the long-distance motoring public,<sup>27</sup> persons living in remote areas, and may offer new forms of emergency services.<sup>28</sup>

14. Satellite DARS may also be able to foster niche programming because it can aggregate small, nationally dispersed listener groups that local radio could not profitably serve.<sup>29</sup> Commenters suggest that satellite DARS could fulfill a need for more educational programming,<sup>30</sup> rural programming,<sup>31</sup> ethnic programming,<sup>32</sup> religious programming,<sup>33</sup> and specialized musical programming.<sup>34</sup> One nationally representative survey found that 10-27% of the respondents indicated a strong interest in accessing programming formats that are not

---

<sup>27</sup> See comments from Owner-Operator Independent Drivers Ass'n., Inc.; Recreational Vehicle Dealers Association; Recreational Vehicle Industry Association; and Winnebago-Itasca Travelers. Similarly, boaters involved in long-distance travel -- either away from shore or along the shore -- could receive continuous radio service from satellite DARS. See comments of J Boats Inc.

<sup>28</sup> See Digital Satellite Broadcasting Corp. Comments, p. 20; Comments of the USDA Forest Service National Weather Program; and Comments of Sat Tech Systems, Inc.

<sup>29</sup> See CD Radio Comments, p. 48; Direct Satellite Broadcasting Corp. Comments p. 25.

<sup>30</sup> See, e.g., comments of David G. Gueulette; Access Innovations Inc.; American Council on Rural Special Education; American Association for Adult and Continuing Education; Association of American Geographers; Learning System Architects; Major Broadcasting Co.

<sup>31</sup> See, e.g., comments from Maine Farm Bureau Association; Wyoming Farm Bureau Federation; NIALl Enterprises; National Parks and Conservation Association.

<sup>32</sup> See, e.g., comments from National Asian American Telecommunications Association; Fiesta Italiana; New York Chinatown Senior Citizen Center; Dialog and Confluence (Vietnamese magazine publisher); Foundation for the Advancement of Hispanic Americans; Professor Arthur Hertzberg (past president of the American Jewish Congress); Italian Industries Association; Multi-Media Computer Communications Inc. (services for Koreans).

<sup>33</sup> See, e.g., comments from American Baptist Churches; The United Church of Christ; and the Radio and Television Commission of the Southern Baptist Convention.

<sup>34</sup> See, e.g., comments from American Council for the Arts; Minnesota Public Radio; and KJAZZ Satellite Radio.



widely available.<sup>35</sup> Evidence from a survey by the National Endowment for the Arts suggests that niche marketing opportunities exist for some of the less popular radio formats.<sup>36</sup>

15. We believe that licensees will have an incentive to diversify program formats and thereby provide valuable niche programming. We recognize that satellite DARS licensees are likely to provide the programming that is most profitable.<sup>37</sup> Nonetheless, given that we anticipate each satellite DARS licensee will control more than 20 channels, each licensee will have an incentive to diversify programming so that one channel will not directly compete with another channel that the licensee itself controls.<sup>38</sup> We have noted the importance of this incentive, particularly with respect to entertainment programming, in other proceedings.<sup>39</sup>

16. In the Notice, we tentatively concluded that implementation of satellite DARS would foster the development of new technology. NAB has argued that U.S. implementation of satellite DARS is not necessary to advance satellite DARS technology.<sup>40</sup> While this may be true, we nevertheless believe that U.S. implementation, by providing large-scale market-based consumer feedback and increased economic incentives for further technological advances, would foster faster and more customer oriented development.

17. We conclude that licensing operators to provide satellite DARS will yield substantial benefits to consumers. We now evaluate whether opponents have met their burden of showing that these benefits are outweighed by the potential harm to listeners from potential loss of terrestrial service resulting from increased competition from satellite DARS.

---

<sup>35</sup> See DSBC Comments at 18-9.

<sup>36</sup> While "Mood/Easy Listening" is the favorite of 9% of respondents, only 4.4% of radio stations (excluding talk format) have that format. Similarly, Classical is the favorite of 6% and Jazz is the favorite of 5% of the persons surveyed, while only 2.7% and 1.1% of radio stations, respectively, have these formats. See Primosphere Comments, Exhibit 5 (article in American Demographics reviewing National Endowment of the Arts Survey, conducted by the U.S. Census Bureau). The format counts are based on data from the 1995 M Street Directory. These underserved consumers may be in smaller markets where, given the small listener base, it is not profitable for local stations to play those consumers' favorite formats.

<sup>37</sup> See NAB Comments at 43, and NAB Reply Comments at. 3-6. See infra, ¶15.

<sup>38</sup> See CD Radio Comments at. 49-50, Primosphere Comments, Confessions at 10-1.

<sup>39</sup> Review of the Commission's Regulations Governing Television Broadcasting, 10 FCC Rcd 3524, 3550-51 (1995); Revision of Radio Rules and Policies, 9 FCC Rcd 7183, 7186 (1992).

<sup>40</sup> NAB comments at 9-10.

## 2. Impact on Terrestrial Radio Listenership

18. In the Notice, we sought comment on the effect of satellite DARS on terrestrial radio listenership.<sup>41</sup> We explicitly requested commenters to consider the characteristics of satellite DARS that distinguish it from terrestrial radio. Commenters often failed to do so. Instead, several commenters implicitly assumed that satellite DARS' effect on local radio would be similar to the effect from competition generated by new local radio stations.<sup>42</sup> Given the distinguishing features of satellite DARS -- it is a national service, it will require new and relatively costly equipment, and it may be offered via paid subscription -- we find that the effect of satellite DARS on terrestrial radio is likely to be significantly smaller than the effect of additional terrestrial radio stations.

19. For example, one commenter includes a consumer survey which suggests that satellite DARS would cause a decline of 11.6% in terrestrial radio listenership.<sup>43</sup> The appropriate interpretation of this figure is not clear, however, because the survey did not take into account the potential cost to the consumer of satellite DARS equipment,<sup>44</sup> and the subscription fee included in the survey was only half of what one satellite DARS applicant (CD Radio) has proposed.<sup>45</sup> Moreover, the survey failed to consider the possible introduction of terrestrial DARS in assessing consumer interest in satellite DARS.<sup>46</sup> For these reasons we

---

<sup>41</sup> Notice, ¶ 14.

<sup>42</sup> NAB Comments, Attachment 9, Kagan Report, focused analysis on the effect of additional local stations under Docket 80-90. See also Reply Comments of Mount Wilson FM Broadcasters, Inc. (filed Oct. 12, 1995) at 3, Reply Comments of Noble Broadcast Group, Inc. (filed Oct. 13, 1995) at 2, Comments of New Jersey Broadcasters Association (filed September 15, 1995) at 2, and Comments of Bonneville International Corporation (filed September 15, 1995) at 2.

<sup>43</sup> NAB Comments, Attachment 5 "Estimating the Audience Diversion from Broadcast Radio by the Introduction of Satellite Digital Audio Radio Service (DARS)," July 1995, Research and Planning Department, National Association of Broadcasters. But see, CD Radio Reply Comments, Appendix A at 12-3.

<sup>44</sup> A satellite DARS applicant indicated that satellite DARS consumer equipment would cost \$300. See Reply Comments of CD Radio at 30. Although the basis for this estimate is not set forth, it appears to be a simple point estimate. We expect that receiver cost might fall over time as production volumes increase.

<sup>45</sup> Id.

<sup>46</sup> We acknowledge, however, that the prospects for early implementation of terrestrial digital service are problematic. See Summary of FM Band IBOC Laboratory Test Results, (Thomas Keller, Chairman DAR Testing Working Group B), NAB 50th

believe that this survey may overestimate the likely decline in terrestrial radio listenership. And yet even in this survey 80% of respondents indicated that they would not reduce the time they spend listening to terrestrial radio if satellite DARS was available. However, we realize that surveys of predicted consumer response to a new and untried service may be somewhat unreliable.

20. By analogy, the diffusion of other new services and technologies may provide valuable perspective on the time period in which satellite DARS' may affect terrestrial radio listenership. In 1994, six years after their introduction, CD players were in just 3.2 percent of all automobiles.<sup>47</sup> This experience is recent, involves high-quality audio service and roughly comparable equipment costs, and relates to automobiles, perhaps the most likely market for satellite DARS receivers. On the other hand, for the first few years after CD players' introduction there were significant technical problems with their operation in automobiles, and CD players are less convenient to operate than radios. These factors may have reduced the rate at which CD players were installed in cars. Nonetheless, CD players offer a useful example by which to evaluate the penetration profile for satellite DARS receivers. Given anticipated satellite launch dates for satellite DARS applicants (1998-1999) and the example of the diffusion of CD players, we believe it is reasonable to project that by about 2005 the over-all penetration rate of satellite DARS receivers in radio listening environments may not be significantly greater than 4%.

21. Estimating listening time diversion depends on the share of listening time allocated to satellite DARS when the listener has a choice between satellite DARS and terrestrial radio. Drawing an analogy with the diffusion of cable services indicates that established programming loses audience share relatively slowly. In 1984, about a decade after the introduction of premium cable services and the development of 24 to 36 channel cable TV systems, cable channels attracted 14% of television viewing time. After another decade, the share of cable channels in television viewing time rose to 30%.<sup>48</sup> An important weakness in this analogy is that the difference between cable programming and network programming during this period is probably significantly greater than will be the difference between satellite DARS programming and terrestrial radio programming. Nonetheless, we believe that owners of satellite DARS receivers will continue to allocate a significant share of their listening time to terrestrial radio in order to hear music or news of local interest.<sup>49</sup> Even with rapid, further

---

Annual Broadcast Engineering Conference, 1996 Proceedings.

<sup>47</sup> CD Radio Comments, Appendix A (Lilley Study), p. 5.

<sup>48</sup> See Primosphere Comments, Appendix A (MTA Study) Table 2.3, p. 50. The share of TV households that cable passed in 1984 was 70%, in 1994, 96%. Figure 2.3.

<sup>49</sup> As noted above, 80% of respondents to a national survey indicated that they would not reduce the time they spent listening to terrestrial radio if satellite DARS was available. See supra, ¶ 19.

penetration of satellite DARS receivers, we expect that satellite DARS' share of radio listening time will grow relatively slowly over decades.

### 3. Impact on Terrestrial Radio Advertising Revenues

22. In the Notice, we asked parties to consider advertising revenues that terrestrial radio might lose because of satellite DARS. The record indicates two possible causes of terrestrial radio revenue loss: competition with satellite DARS for advertising dollars and competition with satellite DARS for listeners' attention.

23. While we recognize that satellite DARS has significant competitive advantages in offering advertising to a national audience with satellite DARS receivers, several factors may limit the possible significance to terrestrial radio of such additional competition. First, at this time, only one out of the four satellite DARS applicants has indicated an intention to implement its system on a non-subscription, advertiser-supported basis.<sup>50</sup> Second, a large share of the national radio audience is not likely to have satellite DARS receivers, at least for a significant period of time.<sup>51</sup> Third, national advertising revenue amounts to only 18% of terrestrial radio advertising revenue and is on average less important for small-market stations than for large-market stations.<sup>52</sup> Local advertising revenue is much more important than national advertising revenue for terrestrial radio's viability and prevalence, and, at this time, we have no evidence that satellite DARS would be able to compete for local advertising revenue.

24. More important to terrestrial radio is possible competition with satellite DARS for listener attention because this new offering could reduce the size of the local listening audience available for terrestrial radio stations to sell. We recognize that a decrease in the audience size could lead to some reduction in terrestrial station revenues. As discussed above, however, we believe the reduction would be modest, although the record leaves room for significant uncertainty.<sup>53</sup>

---

<sup>50</sup> The Kagan Study, p. 5, provides a summary of the applicants' plans. However, nothing we do in this Report and Order limits the remaining applicants to providing only subscription service, so it is impossible to predict whether some or all applicants might eventually provide advertising supported services.

<sup>51</sup> See supra, ¶ 21.

<sup>52</sup> See Kagan Study, p.p. 7, 19.

<sup>53</sup> As we noted in the Notice, ¶ 16, an additional uncertainty is the effect of a reduction in local terrestrial radio listenership on the price of local radio advertising. Some commenters have argued that such a reduction in the supply of listeners would cause the price of local radio advertising to rise. See Comments of CD, Appendix A (Lilley Study) pp. 30-1, and Reply Comments of CD Radio, Appendix A (Peterman Study),

25. Commenters have not fully analyzed the relationship between reductions in listenership and reductions in revenue.<sup>54</sup> We do not necessarily agree with those commenters who assert that terrestrial radio station revenue will fall one-for-one with any fall in listenership. Because the price of local radio advertising may rise, the effect on local radio revenue may be smaller than the effect on listenership. However, regardless of the precise relationship, we do assume that a decrease in listenership will lead to a decrease in advertising revenues, if other variables are held constant.

#### 4. Effects on Terrestrial Stations' Profitability and Viability

26. In the Notice, we asked questions about the impact of satellite DARS on the financial viability of local broadcast stations. In general, the Commission encourages competition for the provision of telecommunications services wherever possible and removes barriers for new competitors. Commenters differ sharply on the effect of satellite DARS on the profitability of terrestrial stations, with estimates of the reduction in terrestrial stations' profitability spanning 2.1-3.5% to 52%-122%.<sup>55</sup> The wide range of these estimates do not allow us to judge the effect of satellite DARS on terrestrial stations' profitability. The Kagan Study, by focusing on historical indicators of revenue and profitability and not considering the time path for satellite DARS diffusion, likely overestimates the potential impact of satellite DARS on terrestrial stations profitability. The MTA Study's audience diversion figures are lower than what we believe, and we question the relevance of their use of the ratio of satellite DARS receiver owners to the total U.S. population, given that segments of the population, such as infants, are not potential satellite DARS owners. We also find their revenue loss projections to be unsubstantiated and unconvincing.

27. The record supports a finding that the impact of satellite DARS would likely be greater on small-market terrestrial stations than large-market terrestrial stations. This result is not surprising because it is likely that the introduction of a 30-channel satellite DARS system

---

pp. 8-10. See also TV listener/revenue example, Lilley Study, p. 6.

<sup>54</sup> See Comments of the NAB, p. 27, Attachment 1 (Strategic Policy Research Study) pp. 36-8, Attachment 5 (Audience Diversion Study), p. 11. These studies do not distinguish between a reduction in a radio station's local listenership from the introduction of new local radio stations (supply side fragmentation) and a reduction in the supply of local radio listeners to local advertisers from satellite DARS audience diversion. Comments of CD Radio, Appendix A (Lilley Study), pp. 30-1 explains why assuming that advertising revenue falls one-for-one with listenership decline is likely to significantly overstate the effect. See also TV example, Id., p. 6.

<sup>55</sup> For the first range of figures, see MTA Study, Table 1.8; for the second range of figures, see Kagan Study, Table 4.

could divert a larger share of the audience in a market with only 6 stations than in a market with 60 stations. Nonetheless, the record does not establish that any predicted reduction in station profitability would harm overall station viability.

28. In fact, the record suggests that profitability figures may be a weak indicator of radio station viability. The wide range in the audience size distribution for existing radio stations suggests that most radio stations could remain viable given plausible audience reductions due to satellite DARS.<sup>56</sup> Despite evidence that a large percentage of radio stations are experiencing losses,<sup>57</sup> there is also evidence that overall the industry is very healthy. The value of radio station purchases in 1996 was 315% higher than in 1995 and radio station values as a multiple of cash flow also rose sharply.<sup>58</sup> Factors such as debt financing and start-up costs may explain why radio stations would stay in business while reporting losses.<sup>59</sup>

29. Our concern about licensing satellite DARS focuses on its impact on the provision of locally oriented radio service. Satellite DARS proponents argue that the ability to offer local content will give terrestrial broadcasters a competitive advantage.<sup>60</sup> Terrestrial broadcasters argue that providing local content is a public service that depends, in effect, on cross-subsidization from more profitable programming.<sup>61</sup>

30. We conclude that the record lacks systematically sampled, quantitative evidence about the listening time, revenue base, and profitability of local content. Nonetheless, if local content were relatively unprofitable for every station, one would expect competition among terrestrial stations to result in minimal local programming on most stations. Yet the record indicates that such analysis is not necessarily accurate; despite vigorous competition among

---

<sup>56</sup> CD Radio Reply Comments, Appendix A (Peterman Study) at 18-21.

<sup>57</sup> See NAB Comments, Att. 14 (Miller, Kaplan, Arase) Exhibit A, showing that 49% of radio stations surveyed lost money in 1994. See also Att. 13 (Fratik), which states that in 1991, "half of all AM fulltime stand alone stations lost more than \$19,000, half of all FM stand alone stations lost more than \$10,367, and half of all AM/FM combos lost more than \$15,978. Since 1991 was a recession year, profitability in that year is likely to have been lower than in other years.

<sup>58</sup> Broadcasting and Cable, February 3, 1996 at 18-19.

<sup>59</sup> CD Radio Comments, InContext Study at 15.

<sup>60</sup> American Mobile Radio Reply at 6-7; CD Radio Reply, pp. 31-33; Digital Satellite Broadcasting Reply, pp. 29-32; Digital Satellite Broadcasting Comments, pp. 23-24.

<sup>61</sup> NAB Reply at 24; Mt. Wilson FM Broadcasters Comments; Noble Broadcast Reply Comments, p. 2; Bonneville International Corp, p. 2; WBCH Comments.

stations,<sup>62</sup> some stations provide much local programming, while others provide relatively little.<sup>63</sup> Competition from satellite DARS may create incentives for at least some terrestrial stations to increase their emphasis on local programming in order to attempt to differentiate their service from satellite DARS. It is unclear the degree to which that might affect overall station profits.

31. In sum, although healthy satellite DARS systems are likely to have some adverse impact on terrestrial radio audience size, revenues, and profits, the record does not demonstrate that licensing satellite DARS would have such a strong adverse impact that it threatens the provision of local radio service.

32. We also note that revenue of terrestrial radio is projected to grow at a real (inflation adjusted) rate of about 4% per year.<sup>64</sup> Such projected revenue should mitigate, at least to some extent, the eventual impact on terrestrial stations of satellite DARS. We also note that recently, the Commission implemented provisions of the Telecommunications Act of 1996 and repealed all terrestrial radio national ownership limits and significantly relaxed local ownership limits.<sup>65</sup> These changes should lead to reduced operating costs and increased profits for terrestrial station owners that take advantage of the new rules. We expect any possible impact of satellite DARS on terrestrial radio's revenue to be relatively small and to occur over a long period of time. We reject as unnecessary a proposed phase-in and evaluation period for satellite DARS.<sup>66</sup> We conclude that opponents of satellite DARS have not shown that its potentially adverse impact on local radio outweighs its potential benefits to the American radio listener.

---

<sup>62</sup> NAB Reply, p. 14.

<sup>63</sup> See NAB Comments, Crystal City Awards.

<sup>64</sup> From 1970 to 1994, total radio advertising revenue increased by a factor of 8, implying a 9.1% nominal growth rate. See Primosphere Comments, Statement of Clifford Burnstein, Exhibit 3. During this period the consumer price index grew on average 5.7% per year. See Economic Report of the President, 1996, Table B-56. Veronis, Suhler & Associates, in a recent "Communications Industry Report", predicted that local radio billings will rise at a compound annual rate of 7.3% over the next five years. See Primosphere Comments, Statement of Clifford Burnstein, p. 4. Over the past five years, the consumer price index has grown 3.1% per year. See Economic Report of the President 1996.

<sup>65</sup> Implementation of Sections 202(a) and 202(b)(1) of the Telecommunications Act of 1996 (Broadcast Radio Ownership), 11 FCC Rcd 12368 (1996).

<sup>66</sup> See proposal of Mt. Wilson FM Broadcasters, p. 5.

33. There is uncertainty inherent in any attempt to predict the impact of satellite DARS on the terrestrial radio industry. The technologies, structure, and regulation of the communications industry are changing dramatically. Developments in the next decade may significantly change the market for both satellite DARS and terrestrial broadcasting. Although opponents of satellite DARS have not shown that it will have a sudden and dramatic adverse impact on terrestrial broadcasting, we cannot entirely rule out the possibility of a major adverse impact. We emphasize that we remain committed to supporting a vibrant and vital terrestrial radio service for the public. Accordingly, we will continue to monitor and evaluate the potential and actual impact of satellite DARS, particularly in small radio markets, so that we will be able to take any necessary action to safeguard the important service that terrestrial radio provides.

34. In addition, we continue to support the efforts of industry committees studying technical standards that would allow terrestrial radio broadcasters to convert to digital transmissions. When it appears that a viable system has been designed, we will act expeditiously to consider changes to our rules to allow AM and FM licensees to offer digital sound. We also remain open to considering other ways to encourage the continued viability of terrestrial radio if the adverse impact of satellite DARS on terrestrial radio proves to be substantially greater than we expect.

## **5. Related Challenge to DARS Allocation: Memorandum Opinion and Order**

35. On February 17, 1995, Interep National Radio Sales, Inc. (Interep) filed a petition for reconsideration of domestic Allocation Order.<sup>67</sup> Interep claims that satellite DARS could have an adverse impact on existing radio services and that, therefore, we should not allow satellite DARS operations until terrestrial DARS is licensed. Interep also suggests a number of guidelines it believes we should adopt with respect to licensing and service rules for satellite DARS.<sup>68</sup> We deny the petition for the reasons given above. That is, the record evidence indicates that the public interest would be served by permitting an innovative new

---

<sup>67</sup> 10 FCC Rcd 2310 (1995). Interep's petition is styled as "Comments and Petition for Partial Reconsideration." Oppositions to the petition were filed by Satellite CD Radio, Inc. and the Digital Satellite Broadcasting Corporation. In addition, the National Association of Broadcasters filed brief comments in support of Interep, urging "the Commission, in its expected Notice of Proposed Rulemaking proposing DARS service and licensing rules, to notice adequately the issues and questions concerning economic harm to local stations. . . ." NAB Comments at 2.

<sup>68</sup> E.g., Interep suggests that "[n]o application for a satellite DARS service should be granted, on either a permanent or experimental basis, until the Commission is prepared to grant applications for a terrestrial DARS service." Petition at 3. It further states that "[w]hen licensing procedures are adopted, priority should be given to existing terrestrial broadcasts [sic] to apply for DARS." Petition at 4.



technology and service, satellite DARS, to become available as a competitive choice for consumers. We note that the petition does not contain any analysis which would undermine those reasons.

36. The Consumer Electronics Manufacturers Association (CEMA) argues in an ex parte submission, based on its preliminary draft report on various digital audio radio technology test results, that satellite DARS cannot be successfully provided at 2.3 GHz. Specifically, CEMA argues that "S-band operations suffer from a significant and startling level of signal blockage," that to provide satellite DARS using S-band frequencies will require hundreds or thousands of gap fillers and that satellite DARS in the S-Band has "no likelihood for nationwide commercial acceptance."<sup>69</sup>

37. We have decided nevertheless to license DARS in the S-Band. CEMA's testing of signal propagation focused on terrestrial technologies; CEMA tested only one generic satellite technology and did not test any of the system designs of the four satellite DARS applicants. Nor does CEMA comment on any of the specific proposals submitted by the four DARS applicants. In addition, CEMA offers no new relevant information. It has been widely known and discussed in the record that DARS providers will need to rely on terrestrial repeaters and gap fillers. As with all new services, the FCC cannot prove or disprove viability. Only the market place can make this determination. CEMA's assertion that satellite DARS is not commercially viable in the S-Band is belied by the interest of many DARS investors who apparently have concluded that a viable satellite DARS service can be offered in the S-Band.

38. Moreover, CEMA's recommendation that the FCC consider other spectrum options for satellite DARS, such as the L-Band, is beyond the scope of this proceeding. The 2310-2360 MHz band [S-Band] was allocated for satellite DARS internationally at WARC-92<sup>70</sup> and domestically in 1995. Frequencies in the L-Band, 1452-1492 MHz were considered and rejected. In the domestic Allocation Order the Commission noted that "commenters strongly favored [S-Band] over, for example, the 1.5 GHz band [L-Band]" in part because the U.S. Government and U.S. commercial mobile aeronautical telemetry (MAT) already operates in the L-Band and it would be very difficult for them to relocate entire operations to the S-Band.<sup>71</sup> Satellite DARS cannot share with MAT systems in the same frequency band in the same coverage area. And even if L-Band had been available, no persuasive evidence suggests

---

<sup>69</sup> The Consumer Electronics Manufacturers Association Vision For Digital Audio Radio Services, submitted as an ex parte presentation on January 29, 1997 (CEMA Ex Parte).

<sup>70</sup> See note 4 supra.

<sup>71</sup> Allocation Order, ¶ 26.

that it is significantly better spectrum in which to receive satellite DARS signals.<sup>72</sup> For the reasons stated above, we find CEMA's argument against proceeding to license satellite DARS applicants in the S-Band unpersuasive.

## **B. Licensing Plan**

### **1. Licensing Options for Satellite DARS Spectrum**

39. In our Notice, we proposed three options for licensing satellite DARS systems.<sup>73</sup> Under Option One, we would have assigned the entire 50 MHz of spectrum allocated for satellite DARS to the four pending applicants, giving each 12.5 MHz, or 10 MHz, if we determined that the lower 10 MHz of the band should not be assigned at the time of our Order due to international coordination constraints. Option Two was to designate less than the full amount of useable spectrum for satellite DARS and to award the remaining spectrum to new applicants. Option Two proposed licensing the four applicants and assigning them each a band segment of less than 10 MHz of spectrum. If either of the two band segments (one for pre-cut off applicants and one for new applicants) could not accommodate all applicants, we would resolve mutual exclusivity via competitive bidding. Option Three was to reopen the cut-off for satellite DARS applications and allow additional applicants to file proposals for all of the useable DARS spectrum.

40. In light of the recent legislation directing the Commission to conduct an auction for use of 25 MHz of the S-band spectrum previously allocated solely to DARS, we cannot adopt any of the three licensing options exactly as proposed in the Notice. After enactment of that legislation and the ensuing *WCS Order*, only 25 MHz remains exclusively for DARS. The licensing plan we adopt today for that remaining spectrum is a logical outgrowth of Option Two, modified in light of the comments received in this proceeding and the recent legislation. In determining how many licenses may be awarded for use of the remaining DARS spectrum and how those licenses should be assigned, we must first determine how much spectrum each satellite DARS licensee will require to operate an economically viable satellite DARS system.

41. In the Allocation Order, the Commission found that, based on the information available at that time, satellite DARS was the best use of all of the 50 MHz of spectrum assigned to U.S. satellite DARS by WARC-92. We requested comment on a number of issues in our Notice to help us determine the best way to make individual satellite DARS frequency assignments. Specifically, we sought comment on the following: the amount of spectrum and number of channels required for a satellite DARS system to be economically viable; the

---

<sup>72</sup> See CD Radio Ex Parte filing, January 31, 1997; DSBC Ex Parte filings, February 7 1997 & February 11, 1997; Primosphere Ex Parte filing, February 3, 1997.

<sup>73</sup> Notice, ¶¶ 31-40.

number of competitors that are necessary to ensure sufficient competition in satellite DARS; the possible number of channels per MHz capable of being delivered via satellite to a mobile user; alternative band plans that could be adopted for satellite DARS; possible uses for spectrum that is not licensed for satellite DARS, and, whether our proposal to license less than 50 MHz of spectrum would create a mutually exclusive situation among the four current applicants. Based on comments we received on these specific issues, we conclude that 12.5 MHz of spectrum is necessary to offer enough channels for an economically viable satellite DARS system. In addition, in light of the recent legislation opening 25 MHz of spectrum for use by additional services, we conclude that two licenses can be awarded.

## **2. Spectrum Requirements and Economic Viability**

42. While we are not sure of the optimal amount of spectrum necessary for satellite DARS, it is our goal to try to determine spectrum block sizes and geographic areas that are most closely suited to provide for efficient provision of the most likely expected use. In this case, because this is a satellite service, the license areas should be nationwide and we have evaluated the evidence about the minimum spectrum block sizes necessary to economically provide satellite DARS. We begin our analysis of determining how much spectrum a single satellite DARS provider will require by considering what the record reveals about how many channels are necessary to operate an economically viable satellite DARS system. Because satellite DARS is a new service, there is an inevitable uncertainty about what precise configuration of channels will best satisfy consumer demand. The record contains no conclusive evidence establishing a specific minimum number of channels needed for a viable DARS system. We will rely on the representations of the applicants which are based on their own market research. The record indicates that a range of channels from 19 to 44 is needed for a viable service.<sup>74</sup>

43. The applicants appear to base their estimated channel requirements on a cable television model in which operators bundle large and diverse packages of channels. The conclusion drawn from the cable television model is that no single channel attracts a large viewing audience, but subscribers value the service because they watch a few channels regularly and occasionally enjoy sampling a wider range of available programming. While the record does not show exactly how many channels a satellite DARS operator must offer to be economically viable, the cable television analogy demonstrates that some critical mass of channels is needed to provide sufficient programming diversity for consumers with diverse tastes.

44. More direct support for the satellite DARS applicants' projections can be found by examining digital audio services packaged with video services and delivered via cable or

---

<sup>74</sup> Estimated channel capacity for the applicants is: (30-40) CD Radio Comments at 8-11; (36-44) AMRC Comments at 2, 25; (19) Primosphere Comments at 17; and (35) DSBC Comments at 35-36.

satellite. Two such nationwide subscription services are Digital Music Express (DMX), offered via cable, and the Primestar direct-to-home video satellite service, a DBS service.<sup>75</sup> Those services each began with roughly 30 channels, but have chosen to increase the number of channels to 60. According to CD Radio, both are now expanding again to offer up to 120 channels.<sup>76</sup> We presume that the satellite DARS applicants would not undertake the risk and expense of implementing satellite systems if the number of channels they propose were not enough to provide a viable service.

45. The satellite DARS applicants calculate that 12.5 MHz of spectrum would be necessary to offer a range of 19 to 44 CD quality audio channels. They contend that 12.5 MHz of spectrum is necessary to support a single viable satellite DARS system.<sup>77</sup> Others commenters disagree. NAB, for instance, proposes that the satellite DARS spectrum be divided into 5 MHz band segments.<sup>78</sup> DSBC and Primosphere counter that NAB's proposed spectrum plan would support a viable satellite DARS system only if at least three or more 5 MHz blocks can be aggregated.<sup>79</sup> AMRC adds that it would be impossible to deliver enough high quality channels in 5 MHz of spectrum to attract a viable audience.<sup>80</sup>

46. A band plan introduced by Cracker Barrel in its reply comments maintains that by using Time Division Multiplexing (TDM) technology, 30 channels of CD quality audio can be accommodated in 8.32 MHz, or 32 channels of CD quality audio could be provided in 8.32 MHz using Code Division Multiplicity (CDM) technology, and thus six operators (presumably six economically viable systems) could be accommodated in the 50 MHz initially allocated for satellite DARS.<sup>81</sup> Cracker Barrel also contends that if all satellite DARS providers use the

---

<sup>75</sup> See CD Radio Comments at 8-11 and Notice, ¶ 15.

<sup>76</sup> CD Radio Comments at 9.

<sup>77</sup> See CD Radio Comments at 11, Primosphere Comments at 17, AMRC Comments at 25, and DSBC Comments at 32.

<sup>78</sup> NAB Comments at 60, n.40. Alternatively, NAB proposes that, with the use of cross-polarization, nineteen 5 MHz band segments could be licensed for satellite DARS. NAB, however, provides no calculation of the number of channels that could be provided by a satellite system in 5 MHz of spectrum and concedes that depending on the technology adopted, a satellite DARS provider might need more than 5 MHz.

<sup>79</sup> See Primosphere Reply at 26 and DSBC Reply at 47.

<sup>80</sup> AMRC Reply at 17.

<sup>81</sup> Cracker Barrel Reply at 9-10. Cracker Barrel initially commented that a standardized use of CDM technology for satellite DARS would permit licensing of more than the four pending satellite DARS applicants (Cracker Barrel Comments 8-12). In its reply

same error correction rates, then as many as eight satellite DARS licensees could be accommodated in the 50 MHz (i.e., each with a 6.25 MHz assignment) and each could offer at least 30 channels of CD quality audio.<sup>82</sup> Cracker Barrel contends that its band plan does not require use of regional spot beams or a higher order modulation constellation to gain additional channels per MHz of spectrum.<sup>83</sup> It asserts that by using 1/3 rate or 1/2 rate FEC as opposed to 1/4 rate as originally proposed by CD Radio and Primosphere, the bandwidth requirement for a 32 or 30 channel CD quality system could be reduced from 12.5 MHz to 8.32 MHz and 6.25 MHz respectively.<sup>84</sup>

47. Satellite DARS applicants assert that Cracker Barrel's assumptions used to derive spectrum requirements do not include techniques to overcome multipath fading present in a mobile environment and do not adequately address the associated limitations on satellite power, weight, launcher capacity, international coordination, or system cost.<sup>85</sup> CD Radio asserts that 12.5 MHz of bandwidth is necessary for its satellite DARS system to provide 33 channels of CD quality audio using a spatially diverse architecture, CDM, and 1/2 rate FEC, which is capable of operating at power flux-density levels that will make coordination with adjacent countries feasible.<sup>86</sup> CD Radio indicates that it has changed to CDM to provide

---

comments, however, Cracker Barrel proposes a counter-plan which would segment the satellite DARS band, apparently abandoning the concept of a standardized use of CDM technology (See Cracker Barrel Reply, Appendix A, at 2).

---

<sup>82</sup> See Ex Parte presentation by Cracker Barrel, dated March 22, 1996.

<sup>83</sup> Cracker Barrel maintains, however, that by using a higher order modulation constellation, such as those used by terrestrial providers in the ATV Grand Alliance (See Notice ¶ 31), the number of channels could be doubled (Cracker Barrel Reply at 10). They note, however, that terrestrial transmitters are high power and generally provide service within a 25 mile radius. Geostationary satellites which have modest transmitter power provide service from a distance of over 23,000 miles. (CD Radio Comment, Appendix B at 9).

<sup>84</sup> See Ex Parte presentation by Cracker Barrel (March 22, 1996), at 7. Cracker Barrel further assesses the trade-offs between using 1/2 and 1/4 FEC rates in its Ex Parte presentation, dated April 4, 1996.

<sup>85</sup> Primosphere Reply at 27-30 and CD Radio Reply at 41, n.115. See Primosphere Ex Parte letter, dated April 9, 1996.

<sup>86</sup> See Ex Parte filing by CD Radio, dated March 29, 1996, and discussion of use of CDM, CD Radio Comments, Appendix B at 10-11. In a spatially diverse satellite system, identical information is transmitted from two satellites with large orbital separation to mitigate the occurrences of signal blockage and multipath fading in a mobile environment.

increased resilience to fading and noise.<sup>87</sup> It concedes that, if it did not employ spatial diversity and instead used a single satellite, it would be possible to transmit approximately twice as many channels in a given amount of spectrum.<sup>88</sup> However, CD Radio maintains that spatial diversity is key to providing high quality audio in a mobile environment. CD Radio contends that abandoning the use of spatial diversity would reduce sound quality, increase fading and blockage, and prove commercially unacceptable to its consumers. While the company notes that these problems could be addressed by increasing satellite power significantly,<sup>89</sup> it points out that any such increase would only add to existing coordination difficulties with adjacent countries.

48. Primosphere maintains that, in the case of CDM technology, even though a signal is coded so that it can be selected from the other signals simultaneously sharing the channel, simultaneous channels can interfere with each other when orthogonality is lost. This sets an effective limit on the number of CDM channels that can occupy a given channel.<sup>90</sup> DSBC asserts that reducing the bandwidth from 12.5 MHz to 10 MHz, or to 8.32 MHz as proposed by Cracker Barrel, while maintaining channel capacity would require greater received signal power (at least 40% more) since the primary coding for a 10 MHz system is much less robust in correcting errors than that found in a 12.5 MHz system.<sup>91</sup> An increase in signal power would increase coordination difficulties with adjacent countries and add cost to satellite DARS receivers and space stations.<sup>92</sup>

---

<sup>87</sup> CD Radio originally contemplated using TDM with the expectation of significantly greater bandwidth being made available for its satellite DARS system (*i.e.*, 20 MHz). Using CDM in 12.5 MHz of bandwidth, however, enables CD Radio to offer 33 CD quality channels on both of its spatially diverse satellites (*i.e.*, 66 total channels). All of the channels are uniquely coded so that they do not interfere with each other even though they occupy the same spectrum at the same time. (See Ex Parte Filing by CD Radio, dated March 22, 1996).

<sup>88</sup> The number of channels per MHz calculated by CD Radio (*i.e.*, 66 channels in 12.5 MHz) is roughly the same number of channels per MHz calculated by Cracker Barrel (*i.e.*, 32 channels in 6.25 MHz). Compare CD Radio Ex Parte filing dated March 29, 1996, with Cracker Barrel Reply at 9-10 and Ex Parte presentation by Cracker Barrel dated March 22, 1996.

<sup>89</sup> Increasing satellite power would have two drawbacks according to CD Radio: an increase of power-flux density levels at the U.S. borders and a prohibitive increase in satellite cost (See CD Radio Ex Parte filing, dated March 29, 1996, at 2).

<sup>90</sup> See Primosphere Reply at 30.

<sup>91</sup> DSBC Reply at 48.

<sup>92</sup> DSBC Reply at 48 and CD Radio, Appendix B at 8-9.

49. We conclude, based on the current record, that each DARS licensee will require at least 12.5 MHz to successfully implement an economically viable satellite DARS system. We believe that licensing less than 12.5 MHz would be insufficient to provide a critical mass of channels required for economic viability and could lead to significant power and cost constraints. We do not find the contrary assertions by NAB and Cracker Barrel persuasive. Moreover, the applicants' successful efforts to increase the spectrum efficiency of their proposals supports their estimate of 12.5 MHz as the minimum amount of spectrum needed. Comparing the channel and associated spectrum requirements of the applicants' original proposals with their existing comments, we calculate that, on average, the applicants have increased the number of channels they propose to provide by seven, despite an average decrease in proposed spectrum use of 14 MHz.<sup>93</sup> The applicants' efforts to improve their spectrum efficiency should not be treated as a detriment. DARS applicants may participate in the WCS auction to acquire additional spectrum if they desire it.

50. While we recognize that further technological advances may result in even greater increases in spectrum efficiency, none of the commenters addressing this issue have demonstrated that they can provide a more spectrum efficient, economically viable, high quality DARS system in less than 12.5 MHz and using current state-of-the-art in satellite technology. The above discussion is indicative of the trade-offs between bandwidth and power that satellite DARS applicants have weighed in their choice of transmission schemes and technology. Because each satellite DARS licensee will be limited to a bandwidth of 12.5 MHz, the trade-offs between increased power and channel capacity is particularly critical to overall satellite system design. We will not attempt to impose our judgments in this regard on the satellite DARS licensees and we will allow licensees to use the technology, channelling plans, modulation schemes, and multiple entry techniques of their choice within their 12.5 MHz band segment.

### 3. International Coordination Obligations

51. Based on the recent legislation passed by Congress directing the Commission to reallocate and auction the 2305-2320 MHz and 2345-2360 MHz bands, we are licensing only the 2320-2345 MHz portion of the 2310-2360 satellite DARS band exclusively for satellite DARS. However, before satellite DARS service can be offered to the public, we will require satellite DARS licensees to complete detailed frequency coordination with existing operations in adjacent countries to prevent the potential for unacceptable interference.<sup>94</sup> The goal of the

---

<sup>93</sup> See NAB Comments at 59-61, comparing the channel capacity and associated spectrum requirements of each of the applicants according to their original proposals and their comments to the Notice.

<sup>94</sup> Satellite DARS licensees' authority to launch and operate will be conditioned on the completion of international coordination obligations.

coordination process is to reach agreement with affected users on an operating arrangement which harmonizes the use of the radio frequency spectrum.

52. In the Notice, we discussed potential issues that might arise during coordination of U.S. satellite DARS systems with existing operations in adjacent countries.<sup>95</sup> Based on what we knew then about the relatively large number of fixed Canadian terrestrial stations licensed in the 2310-2320 MHz band, we tentatively concluded that the lowest 10 MHz in the 2310-2360 MHz band would be difficult to coordinate for satellite DARS. Indeed, one option in the Notice proposed to license only spectrum above 2320 MHz for satellite DARS "[t]o alleviate the potentially difficult and lengthy coordination" posed by the presence of the nearly 200 Canadian terrestrial stations between 2310 and 2320 MHz.<sup>96</sup> This option would seek to avoid requiring one satellite DARS licensee to be subject to coordination with a greater number of fixed terrestrial systems than other licensees. We requested comment on our tentative conclusion.

53. In the Notice we also observed that the upper portion of the 2310-2360 MHz band would likely present other potential obstacles to coordination with adjacent countries. For example, we cited a CD Radio study showing that Canada generally licenses its Mobile Aeronautical Telemetry (MAT) operations between 2350 and 2360 MHz. Despite the operation of MAT above 2350 MHz, however, certain of the satellite DARS applicants maintained that the uppermost spectrum in the DARS band should be assigned to the first licensee that met its milestone requirements.<sup>97</sup> Based on this proposal, it appeared to us that the satellite DARS applicants did not expect sharing with MAT operations of adjacent countries to be an insurmountable hurdle. We requested specific comment on whether our different assessment was correct. Although the question of whether to reserve the entire S-band (2310- 2360 MHz) exclusively for satellite DARS has been determined by the recent Congressional legislation, discussed above, we discuss below terrestrial operations in the S-band that may affect future satellite DARS coordination.

54. We initiated formal negotiations with the Canadian Administration after release of our Notice. The Commission used the information from these recent meetings to re-assess the current operating environment in the 2310-2360 MHz band. In meetings with Canada following release of the Notice, International Bureau staff learned that the number of fixed

---

<sup>95</sup> Notice, ¶ 80. Coordination with administrations other than Canada also will be necessary.

<sup>96</sup> Notice, ¶ 66. At the time our Notice was released, approximately 78% of the fixed terrestrial stations licensed in Canada in the 2130-2360 MHz band were licensed below 2320 MHz.

<sup>97</sup> See Notice, ¶ 66. See specifically, Supplemental Comments of DSBC at 10 and CD Radio at 9.



terrestrial systems in the lower portion of the band has not changed significantly since we accepted satellite DARS applications for filing.<sup>98</sup> However, Canada informed our staff that Canadian MAT systems are currently licensed and operating at frequencies throughout the S-band from 2329.25-2390 MHz.<sup>99</sup> Upon receipt of this new information from Canada, we forwarded it to the applicants and entered it into the public record so that the applicants' technical experts and others could provide comment.<sup>100</sup>

55. *The Fixed Service* The applicants recognize that detailed coordination with foreign systems is unavoidable. Coordination between satellite DARS and Fixed Service systems (FS) is required because the power levels at which the applicants propose to operate their systems to achieve sufficient quality service in a mobile environment are higher than the thresholds levels which have triggered on-going bilateral coordination with adjacent countries.<sup>101</sup> Detailed coordination would therefore be necessary with every FS station that is within the satellite DARS transmitting antenna gain contour unless the power levels of the proposed satellite DARS systems is reduced or measures are taken by the fixed terrestrial service to mitigate unacceptable interference from satellite DARS (e.g., re-pointing the receive antenna sufficiently away from the geostationary satellite orbit or upgrading receiver equipment).

56. According to the international allocation, adjacent countries are free to license additional fixed and mobile terrestrial systems on frequencies between 2300-2483.5 MHz. We have confirmed that Canada, alone, has licensed and will continue to license FS systems throughout the 2310-2360 MHz band. Currently, approximately 20% of the total number of systems licensed in Canada are above 2320 MHz.

57. *Mobile Aeronautical Telemetry* The threshold power levels necessary to protect foreign MAT systems are expected to be similar to the levels which the U.S. has established

---

<sup>98</sup> The number of fixed terrestrial stations in Canada increased from 213 in 1993 to 221 in 1994, and to 231 in 1995.

<sup>99</sup> Currently, there are eight MAT facilities licensed in Canada which operate on the following frequency assignments below 2360 MHz: 2330 MHz, 2335 MHz, 2345 MHz, 2348 MHz, 2352 MHz, 2353 MHz, 2356 MHz, and 2360 MHz.

<sup>100</sup> See letter from Satellite Engineering Branch (SEB letter), dated February 16, 1996, to representatives of CD Radio, DSBC, AMRC and Primosphere, respectively, and responses thereto that address coordination in these bands for satellite DARS.

<sup>101</sup> Information from bilateral negotiations reveals that a level of -154/-144 dB(W/m<sup>2</sup>/4kHz) would be necessary, for low/high elevation angles, to protect FS systems in adjacent countries.